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March 2015

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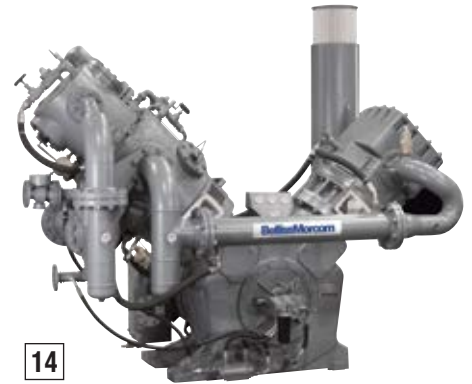
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FROM THE EDITOR

Plastic Molding



Sidel and Kronen are two of the world's largest PET stretch blow molding machine manufacturers. Our lead article this month outlines how they continue to aggressively re-engineer their machines so their customers, like Pepsi Bottling, require less energy in the form of compressed air and electricity to run them. PET Compressor experts from Bellis & Morcom and AF Compressors also comment on the improvements of the air recycling systems, integrated into the blow molders, and also on the lower final blow pressures (290 to 365 psi) being made possible by the light-weighting of water bottles.

Pete Rhoten has been designing PET compressor systems, for Hope Air Systems, since 1979. You could and may say he's forgotten more than I know about the topic. I'm very pleased he's sharing a very practical article titled, "11 Key Considerations for Selecting a PET Air Compressor System." The article includes a couple of "tear this chart out and keep it" tables for operators. One is a high and low-pressure compressed air piping selection chart and the other is a maintenance check-list. Practical information.

How can compressed air flow meters help improve plant efficiency? Contributing Editor Scott Williams interviews New Hampshire-based compressed air consultant Jeff Wright on his vast experience using flow meters in his system assessments. Roger Dennison, President of CDI Meters, also offers his significant expertise on where and how to install thermal mass dispersion technology compressed air flow meters for reliable readings.

Bob Wilson, from PEMCO Services, provides another interesting article this month. It's titled, "The Final Cost is Determined by how Compressed Air is Used." How many factories can really pin-point how their air is used? The article goes on to provide a detailed look at different compressed air storage strategies and approaches.

Acrylon Plastics is a Canadian plastic parts company deploying rotary molding processes. They experienced significant peaks in compressed air demand resulting in low plant pressure and high energy bills. Ron Marshall, on behalf of the Compressed Air Challenge®, again delivers an interesting case study at this site where a 1,060 gallon compressed air storage tank, a flow controller, and a 75 horsepower VSD air compressor were added, incrementally, to solve the pressure problems and reduce energy costs.

Thank you for investing your time and efforts into **Compressed Air Best Practices®**.

ROD SMITH

Editor

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* The Cover Photo for the 2015 March Issue of Compressed Air Best Practices® Magazine was supplied courtesy of Sidel, Inc.

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INDUSTRY NEWS

Atlas Copco Ranked Top Sustainable Machinery Company

Atlas Copco, a leading provider of sustainable productivity solutions, was recognized as one of the world's most sustainable companies in the annual Global 100 list.

The list, presented at the World Economic Forum in Davos, Switzerland, ranks companies that prove they are increasing productivity while using less resources. Atlas Copco is ranked 23rd overall, up from 46th last year, and is number one in the machinery industry. It was the ninth time Atlas Copco appeared on the list.

"We strive to deliver products and services that are energy efficient, safe and ergonomical with minimal impact on the environment," said Mala Chakraborti, Atlas Copco Vice President Corporate Responsibility. "We continue to increase our focus on sustainability to enhance customer productivity and create value for our shareholders."

Atlas Copco's sustainability goals include boosting customer energy-efficiency by at least 20% between 2010 and 2020, decreasing CO₂ emissions, working actively to eliminate corruption, and promoting access to clean drinking water in countries in need.

The Global 100 Most Sustainable Corporations in the World index, known as the Global 100 list, is presented annually at the World Economic Forum. The ranking evaluated 4609 publicly listed companies globally that are measured against sustainability indicators such as safety performance and revenues in relation to consumption of energy and water. To read more, see <http://global100.org>.

About Atlas Copco

Atlas Copco is a world-leading provider of sustainable productivity solutions. The

Group serves customers with innovative compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems. Atlas Copco develops products and service focused on productivity, energy efficiency, safety and ergonomics. The company was founded in 1873, is based in Stockholm, Sweden, and has a global reach spanning more than 180 countries. In 2013, Atlas Copco had revenues of BSEK 84 (BEUR 9.7) and more than 40,000 employees.

Teseo Donates Piping System to Brescia University

TESEO srl, specialized in the design and production of distribution systems for compressed air, vacuum, nitrogen and other fluids under pressure, has donated a compressed air distribution system to DIMI, the Department of Mechanical and Industrial Engineering of the University of Brescia, for the Actuators and Components laboratory of the Machine Applied Mechanics unit.

The donation by TESEO includes 45 meters of AP28 aluminum piping with a diameter larger than 1 inch, drop columns, pressure gauges, couplings, joints and connection materials, besides the installation and testing service.

The Applied Machine Mechanics unit performs research in the field of simulation and experimentation of actuators for industrial automation, design of mechanical systems and servo mechanisms, kinematics and dynamics of industrial robots, models and procedures for the functional optimization of mechanical devices, robot calibration, biomechanical analysis of human motion, study and modeling of friction and lubrication.

The activity of the Actuators and Components laboratory supports formal education in the

classes, with the purpose of consolidating skills in the pneumatic, electro-pneumatic and hydraulic domains, using dedicated panels and benches. The laboratory also performs testing activities for graduation papers and stages inside the university, concerning topics such as applied mechanics, electric and fluid drives, industrial robotics, automatic machinery and controls.

“TESEO has always maintained close relationships with the academic world, as we believe that collaboration between university and enterprise is essential to advance research in all industrial domains — said Gianfranco Guzzoni, CEO of TESEO —. Based on this close synergy, we were enthusiastic to



Paolo Nardi, from Teseo, with representatives from Brescia University (left to right).



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INDUSTRY NEWS

equip the laboratory of the Applied Machine Mechanics unit of the University of Brescia with a TESEO compressed air distribution system, which we hope will be useful to professors and students.”

About TESEO srl

Teseo srl was founded in 1988 and immediately emerged as a pioneering, innovative and creative company. In the early '90s, Teseo was the first company worldwide to develop a modular system of aluminum profiles for the distribution of compressed air. Today, these systems have set a reference at international level for fluid power distribution such as compressed air and vacuum, both in small handicraft workshops and the big industry.

ENMET, LLC Announces New President, Norman Davis, Jr.

ENMET, LLC is announced the appointment of Norman Davis, Jr. as the new President succeeding Dr. Verne Brown who held that position for 43 years until his passing. Mr. Davis brings a wealth of knowledge to this position with a background in executive management and in business development, focused in the safety and instrument sensor technology market. He has held a wide variety of positions and was the former President of Microsensor Systems which was acquired by MSA (Mine Safety Appliances) in 2005. Mr. Davis' education is in chemistry, environmental science and industrial hygiene.

Founded in 1970, ENMET (www.enmet.com) is a leading manufacturer of hazardous gas



Norman Davis, Jr., President, ENMET LLC.

detection equipment for health, safety and medical applications. Products range from compressed air line monitors to portable detectors and continuous multi-channel fixed systems which address a wide variety of hazardous gas conditions. ENMET also designs custom engineered gas and vapor detection systems for a wide range of applications.

In July 2014, ENMET Corporation was acquired by Chicago-based Benford Capital Partners and the new entity, ENMET, LLC, under the leadership of President Norman Davis, Jr. will remain headquartered in Ann Arbor, MI.

www.enmet.com

Parker FAF Announces Compressed Air Challenge (CAC) Level II Training Classes

Parker Hannifin Finite Airtek Filtration Division (FAF) is excited to offer the Compressed Air Challenge (CAC) Advanced Management of Compressed Air Systems (Level II Training Class) at their Lancaster facility. FAF will be co-hosting with two instructors who have been screened and qualified by the CAC that will teach the training session.

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The Compressed Air Challenge® is a voluntary collaboration of industrial users; manufacturers, distributors and their associations; facility operating personnel and their associations; consultants; state research and development agencies; energy efficiency organizations; and utilities, that are determined to help companies realize the benefits of smart compressed air management.

Classes will take place March 11th - 12th, and April 1st - 2nd. Prior to attending, Level I

training needs to be completed and can be done online at www.compressedairchallenge.org.

For details on how to register, please call 716-686-6400 or email marvin.wash@parker.com.

Kobe Steel Honored for Innovation

Kobe Steel, Ltd. (also known as **Kobelco**) has been named to the Thomson Reuters 2014 Top 100 Global Innovators list. In recognition of this achievement, Thomson Reuters presented Kobe Steel yesterday with a trophy for the award. This is the first time that Kobe Steel has been recognized as a Thomson Reuters Top 100 Global Innovator.

The program honors 100 of the world's most innovative organizations. The IP &

Science business of Thomson Reuters, one of the world's leading sources of intelligent information for businesses and professionals, evaluates companies and organizations using a series of metrics to analyze their patent activity and protection of intellectual property. The organizations are recognized for their innovation generated by the creative intellectual property derived from their research activities. The Thomson Reuters Top 100 Global Innovators program began in 2011. The criteria for the award are as follows:

1. Overall patent volume: Organizations with 100 or more patented new inventions from the most recent five years
2. Patent grant success rate: Ratio of patent applications that have been granted

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INDUSTRY NEWS

3. Global reach: Number of patents registered in four major world markets (Europe, the United States, China and Japan)
4. Patent influence: Frequency of patents cited by other companies in the patenting of their inventions

Thomson Reuters said that “of the four criteria, Kobe Steel received high scores on patent grant success rate and global reach. In particular, it received its highest score in the patent grant success rate. These factors led to Kobe Steel’s first selection to the Top 100 list.”

Of the Top 100 innovators, 39 are based in Japan, an increase from 28 in the previous year, overtaking the United States for the first time. Kobe Steel will continue to actively pursue research and development to create new value. At the same time, in the global market it will strive to protect and utilize the intellectual property it has generated.

About Kobe Steel

Kobe Steel, Ltd. is a diversified manufacturer with its major businesses concentrated on materials and machinery. The materials business comprises iron and steel, welding, and aluminum and copper products. Machinery includes industrial machinery, engineering and construction equipment, as well as environmental solutions. Other important businesses are wholesale power supply and real estate. The company has head offices in Kobe and Tokyo, Japan. For more information, visit: www.kobelco.com.

Many of the company’s businesses operate under the Kobelco name including air compressors. Together with Rogers Machinery Company, Kobelco is the largest manufacturer of oil-free air compressors based in North America.

Plastics Machinery Shipments Continued to Rise in Q3 of 2014

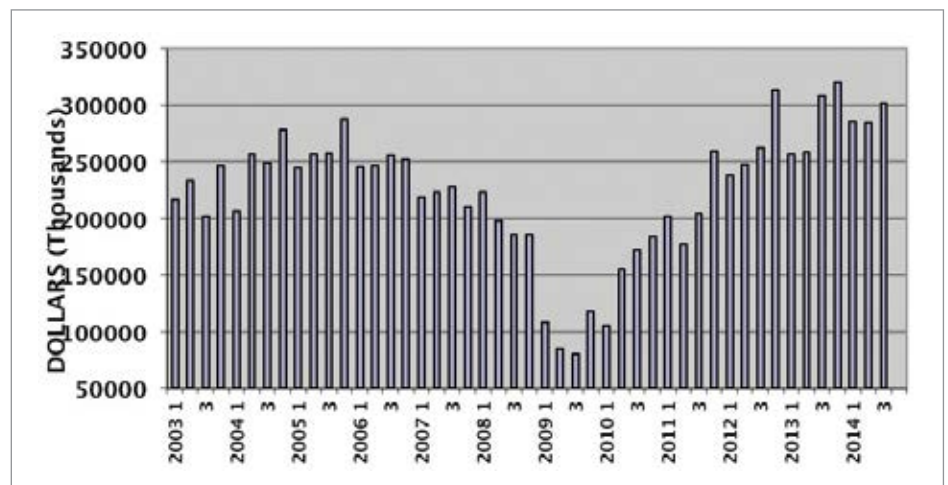
Market demand for plastics machinery continued to grow in the third quarter of 2014, according to statistics compiled and reported by SPI: the Plastics Industry Trade Association’s Committee on Equipment Statistics (CES).

“The market conditions that drive investment in new industrial equipment have prevailed throughout all of 2014, and I expect these conditions to persist in 2015. These are: low interest rates, and the need for increased productivity in order to meet rising aggregate demand,” according to Bill Wood, the plastics market economist who analyzes and reports on the plastics machinery market sector for the CES.

Shipments of primary plastics equipment (injection molding, extrusion and blow molding equipment) for reporting companies totaled \$301.4 million in Q3. This is 6 percent higher than the revised shipments total of \$284.3 million in Q2 of this year, and is down only 2 percent compared with the robust total from Q3 of 2013. For the year to date, the total value of primary equipment shipments is up 6 percent compared with last year.

A closer look at the CES data show that the shipments value of injection molding machinery decreased 4 percent in Q3 of 2014 compared with the total from Q3 of 2013. For the year to date, shipments of injection molding machinery are up 4 percent. The shipments value of single-screw extruders dropped 14 percent in Q3 compared with last year. For the year to date, single screw extruder shipments are down 6 percent. The value of shipments of twin-screw extruders (which includes both co-rotating and counter-rotating machines) jumped 33 percent in Q3. For the year to date, shipments of twin screw extruders are up 35 percent. The shipments value of blow molding machines advanced by an estimated 27 percent in Q3. For the year to date, shipments of blow molding machinery are up an estimated 25 percent.

The CES also compiles data on the auxiliary equipment segment (robotics, temperature control, materials handling, etc.) of the plastics machinery industry. New bookings of auxiliary equipment for reporting companies totaled a record-breaking \$108.2 million dollars in Q3. This represented a gain of 8 percent compared with the total from Q3 of 2013. For the year to date, bookings of auxiliary equipment are up 12 percent.



Primary plastics equipment shipments

The trend upward in the CES data on plastics machinery shipments corresponds with the trends in the two major data series compiled by the U.S. government that measure activity levels in the industrial machinery sector. According to the Bureau of Economic Analysis, business investment in industrial equipment escalated by 16 percent (seasonally-adjusted, annualized rate) in Q3 when compared with Q3 of 2013, and for the year to date investment is up 13 percent. The other important machinery market indicator, compiled by the Census Bureau, showed that the total value of new orders of industrial machinery jumped 47 percent in Q3 when compared with the total from last year, and for the year to date industrial machinery orders are up a stellar 34 percent.

“From a global perspective, the North American region will be the strongest in terms of total economic activity in the coming months. With the exception of China and India, the economic activity in most of the other major economic regions of the world will see sluggish or even negative growth. But strong demand in the U.S. help to sustain the momentum in the global economy in 2015,” said Wood.

About SPI

The SPI Committee on Equipment Statistics (CES) collects monthly orders and shipments data from manufacturers of plastic injection molding, extrusion, blow molding, thermoforming, hot runners and auxiliary equipment.

Founded in 1937, SPI: The Plastics Industry Trade Association promotes growth in the \$373 billion U.S. plastics industry. Representing nearly 900,000 American workers in the third largest U.S. manufacturing industry, SPI delivers legislative and regulatory advocacy, market research, industry promotion and the fostering of business relationships and zero waste strategies. SPI also owns and produces the international NPE trade show. All profits from NPE are reinvested into SPI's industry services. Find SPI online at www.plasticsindustry.org and www.inthehopper.org.

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SIDEL AND KRONES BLOW MOLDERS STRETCH CONSERVATION POTENTIAL

By Neal Lorenzi, Contributing Editor



Sidel Matrix blow-molders can blow PET bottles in a broad size range (from 0.1 liter to 3.5 liters) with many distinctive bottle shapes.

► The beverage industry has been using polyethylene terephthalate (PET) 2-liter plastic bottles primarily for packaging carbonated soft drinks since the 1970s. As that market has grown to encompass bottled drinking water, stretch blow-molding machines continue to produce those plastic bottles. The concept is simple: A pre-form plug is inserted into the blow molding machine heated, and compressed air is injected, “blowing” into the pre-form to create the bottle.

Since the 1970s, blow molding systems have reached a higher level of efficiency, using

capabilities such as electromagnetically controlled stretch systems and compressed air recycling components. Intelligent systems that regulate the blowing process, reduce scrap and automatically eliminate bottle process deviations have been added as well.

Manufacturers of stretch blow-molding equipment strive to provide machinery that is faster and more efficient to drive down the total lifecycle costs of their equipment. This, in combination with advances in container material technologies, is changing the requirements of the compressed air needed

to support the process. These changes include lower pressure for forming the containers and reduced volume due to recovery capabilities.

Air Recovery Systems Capture Portions of High-Pressure Air

Mike Bakalyar, manager, high pressure and niche products, Belliss & Morcom, Gardner Denver Inc., Quincy, IL, an air compressor manufacturer that provides compressed air to PET bottle blowing applications, says that blow molders are being designed with increased efficiency in regards to the way that heating and compressed air are used in the process.



“Air recovery features, on blow molders, are reducing overall volume requirements of high-pressure supply.”

— Mike Bakalyar, Gardner Denver Bellis & Morcom



The Contiform 3 Stretch Blow Molder from Krones Inc. features an electromagnetic linear-drive control system.

One of the biggest advances is the air recovery feature that captures a portion of the high-pressure air after the blow process and utilizes this to support low-pressure air requirements within the machine. "This feature has reduced overall volume requirements of high-pressure supply," he explains. "In many cases, the recovered air is in excess of the mold process requirement and is available to augment low-pressure plant air needs or return air to the high-pressure compressor, eliminating a stage of compression."

Joe Mashburn, area sales manager, AF Compressors USA, Carrollton, GA, another air compressor manufacturer that provides compressed air to PET bottle blowing applications, says the latest advances include the lowering of blow pressures due mainly to the light-weighting of bottles. Improvements in air recovery systems by blow mold machine manufacturers have also reduced the energy consumption related to compressed air.

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SIDEL AND KRONES BLOW MOLDERS STRETCH CONSERVATION POTENTIAL

“In the past, normal blow-mold air pressures to produce PET bottles were typically 35 to 40 bar (510 to 590 psi),” he explains.

“The light-weighting of the containers, particularly for water bottles, has reduced the final blow pressure to the 20 to 25 bar (290 to 365 psi) range. This lower pressure significantly lowers the volume of air needed to blow the bottle.”

Air recovery systems also reduce overall compressed air requirements by recycling some of the high-pressure, blow-mold air for low-pressure service air on the blow molding machine, including air for pre-blowing the bottle before high-pressure air is used for the final blow, he adds. In addition, machine suppliers have decreased the dead space between the blow

valve and the mold, which also decreases compressed air requirements.

“Early on, when air recycling systems were introduced, we found that the systems were not saving as much air as advertised. Since then, improvements made by blow-mold machine manufacturers have given end users and their compressor suppliers more accurate data to properly size the appropriate

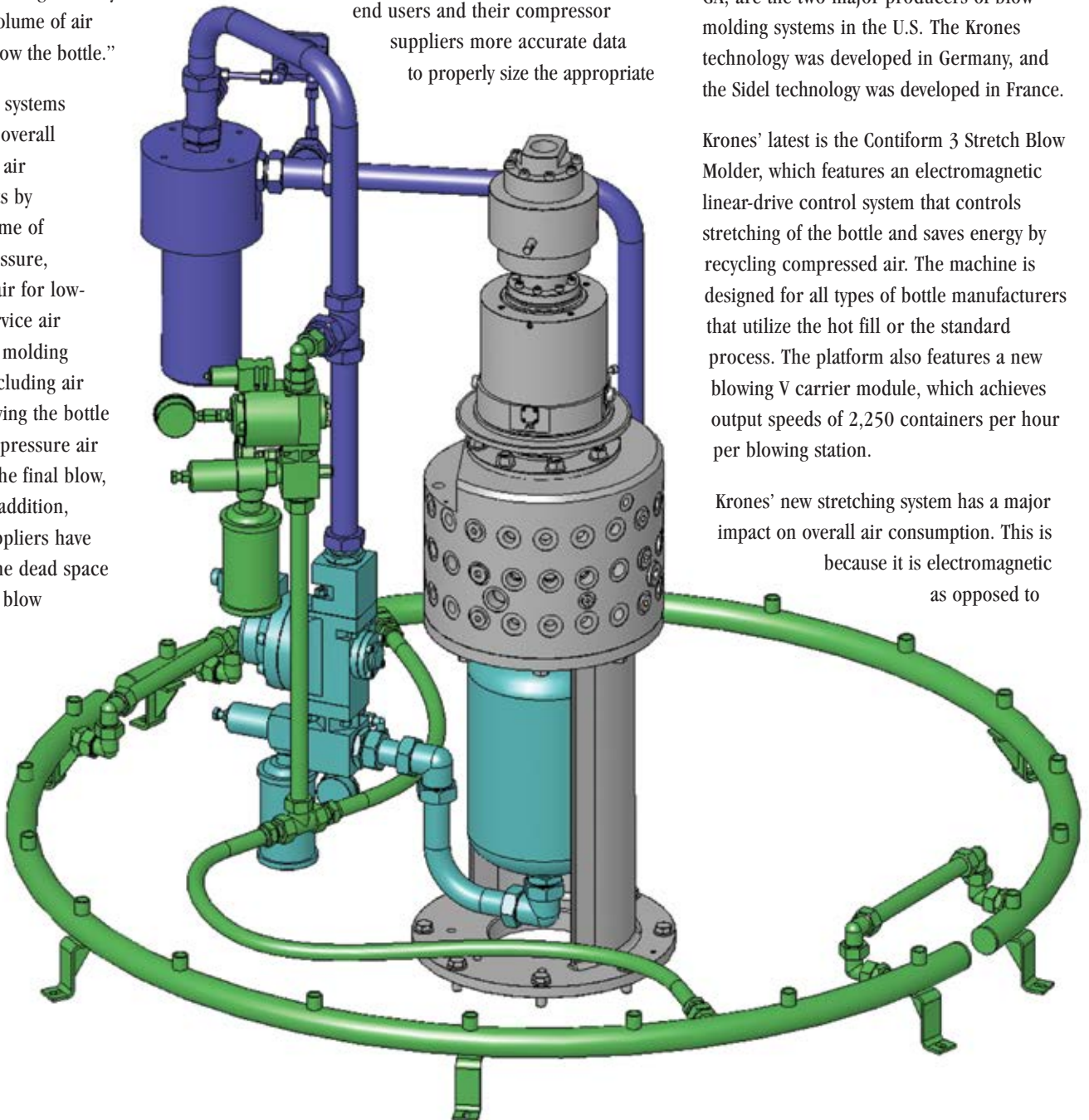
compressor for the application,” Mashburn explains.

Krones Contiform 3 Innovates Stretching System and Reduces Dead Space Volume

Krones Inc., Franklin, WI, and Sidel, Norcross, GA, are the two major producers of blow molding systems in the U.S. The Krones technology was developed in Germany, and the Sidel technology was developed in France.

Krones’ latest is the Contiform 3 Stretch Blow Molder, which features an electromagnetic linear-drive control system that controls stretching of the bottle and saves energy by recycling compressed air. The machine is designed for all types of bottle manufacturers that utilize the hot fill or the standard process. The platform also features a new blowing V carrier module, which achieves output speeds of 2,250 containers per hour per blowing station.

Krones’ new stretching system has a major impact on overall air consumption. This is because it is electromagnetic as opposed to



Sidel's air recovery system generates savings in capital expenditures and operating costs.



“A new valve circuit makes it possible to re-use up to 40 percent of exhaust air from the blowing process.”

— David E. Raabe, Krones Inc.

pneumatic and requires no compressed air, according to David E. Raabe, who oversees the technical sales of plastic technology at Krones.

Minimized dead space volume is another feature of the Contiform 3 that reduces operational costs. “In the blowing station, the so-called dead space volume has been reduced to a minimum by utilizing every design possibility to the maximum,” Raabe explains. Other features, such as the Air Wizard Plus air recycling system, ensure maximum compressed air savings for every process. A new valve circuit makes it possible to re-use up to 40 percent of exhaust air from the blowing process.

Further reductions have been made in the radiant heat compartment in the heating tunnel. The infrared oven requires 15 percent less energy than its predecessor, due to the Krones closed-tunnel oven design.

“The new stretch system also is maintenance-free and easy to program on a central HMI (human-machine interface) touchscreen. It calibrates the correct air saves automatically and has no stretch-rod shock absorber stops. This reduces mechanical problems that can occur during changeovers,” Raabe says.

Sidel Matrix Reduces Heating and Compressed Air Energy Consumption

Sidel recently introduced the Matrix blow molder, a modular blow molding system available in 200 configurations that reduce energy and material consumption as well as

downtime. The system produces lightweight PET containers at a speed of 2,250 bottles per mold per hour.

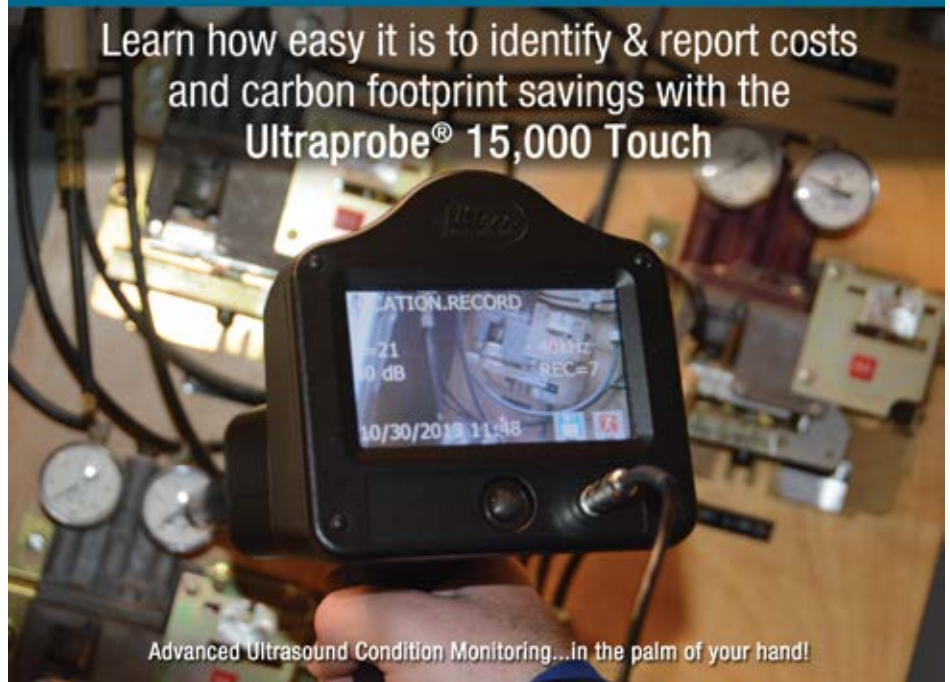
Electrical consumption is reduced by 45 percent versus that of a conventional oven because it requires fewer heating modules and lamps, according to David Bonhomme, Sidel’s customer service director for North America. The system uses installed power more efficiently, resulting in reduced preform heating time. In addition, air consumption is

reduced, resulting in compressed air savings of up to 30 percent.

The system is designed to reduce air consumption during the blow molding process. Instead of releasing compressed air into the atmosphere, the system uses it to feed the pre-blow circuit and the pneumatic system. The extra air is released in the low-pressure circuit of the plant. As a result, the blow molder produces low-pressure compressed air that can be used for downstream operations. The

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SIDEL AND KRONES BLOW MOLDERS STRETCH CONSERVATION POTENTIAL

system also recovers the high-pressure air needed for the next blowing cycle.

Available as an option is the Intelliblower, a system that automatically detects and eliminates bottle process deviations and reduces scrap. “The Intelliblower has a strong impact on production uniformity and packaging quality because it ensures control of the pre-blow phase parameters instead of focusing on heating regulation,” Bonhomme says.

Sidel Helps Midwest Coca-Cola Bottling Co. Reduce Blowing Air Pressure by 50%

Sidel works with a variety of customers, including converters that produce empty PET

containers on behalf of their clients and brand owners who produce, fill, label and palletize PET bottles for the consumer market.

Sidel recently helped Midwest Coca-Cola Bottling Co., Eagan, MN, reduce blowing air pressure by more than 50 percent in its blow molding operation. The company manufactures bottles and distributes Coca-Cola products throughout the Midwest, and it used Sidel’s Eco Booster service to reduce blowing air pressure and oven electricity across four of its lines, according to Jim Tierney, maintenance manager at Midwest Coca-Cola Bottling.

Sidel’s Eco Booster service analyses a line to identify potential opportunities for savings. Efficiency measurement tools are installed that

record the consumption of all utilities (air, water, electricity and carbon dioxide) by individual machines, lines, and production zones. They can even record the activity of an entire plant. Along with measuring consumption and calculating energy costs per bottle produced, the service helps determine the correlation between consumption levels and production procedures (startup, shutdown, changeover and cleaning). This information is used by beverage producers to support initiatives for reducing waste.

“Having the Sidel experts work with our guys to adapt our equipment brought peace of mind that the intervention would be quick and easy, and ultimately led to a short return to production and faster ROI,” Tierney notes.

New Plastic Materials and Thinner Wall Thicknesses Likely to Continue Pressure Reduction Trend

What future advances do experts see in the area of blow molding, especially as it applies to compressed air? Mashburn of AF Compressors USA says there is a possibility that blow pressures will continue to decrease for applications where the weight of the bottle is reduced. “We’ve heard that some testing has been performed at pressures as low as 17 bar,” he says.

New materials and thinner wall thickness will likely reduce the pressure required to form bottles, says Bakalyar of Belliss & Morcom. “It also is likely that the technology will be applied more locally to the product being contained. This trend will increase the population of smaller blow mold stations requiring smaller supporting compressors. Belliss & Morcom compressor products are ready to accommodate these anticipated changes,” he says.



A Belliss & Morcom Oil-Free PET Air Compressor



An AF Compressor PET package equipped with the R-Back-5 Air Recycling System

Bonhomme of Sidel sees the following technological advances in blow molding applications:

- Blow molding pressure will decrease, consequently lowering energy use and costs.
- Enhanced air recovery systems will increase savings in operational costs.
- Implementing new packaging and light-weighting capabilities to create containers will help lower blowing pressures.
- Researching environmentally friendly materials (other than PET) will enable customers to blow mold containers at very low pressures.

- Increasing the use of machine intelligence will help to detect and troubleshoot air leaks and optimize equipment efficiency.

If these experts are correct, the blow molding process will continue to evolve and become even more efficient, which is good news for industries producing large quantities of plastic bottles. **BP**

For more information about the companies mentioned in this article, visit AF Compressors USA (www.afcompressors.com), Belliss & Morcom, Gardner Denver Inc. (www.belliss.com), Krones Inc. (www.krones.com), and Sidel (www.sidel.com).

Author Bio

Neal Lorenzi is a freelance writer based in Mundelein, IL. He has covered a wide range of industries during his 25 years as a writer and editor.

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11 KEY CONSIDERATIONS FOR SELECTING A PET AIR COMPRESSOR SYSTEM

By Pete Rhoten, Senior Project Engineer, Hope Air Systems



Three-stage, oil-free, water-cooled piston air compressor and high-pressure refrigerated air dryer for PET systems from AF Compressors.



Three-stage, reciprocating piston high pressure air compressor for PET — Sauer Compressors USA, WP271L.

► In 1979 I received a call from a business friend that had just purchased his first single-stage base cup blow machine. He was surprised to find out that he actually needed something more than 100 psi of plant air to blow bottles. This was my entry into engineering a polyethylene terephthalate (PET) compressor system. Since then, I have engineered and delivered over 350 systems — from Tobago to Tibet — and many locations in between.

In the more than thirty years that I have been engineering and delivering PET air compressor systems, pressures have gone from 250 psi base-cup, bubble-blowing applications — up through 650 psi for intricate, high-speed bottle designs. The trend today is to reduce blow pressure as much as possible for energy conservation.

Types of PET Air Compressor Systems

PET air systems started out with three-stage, air-cooled, lubricated piston units in multiple quantities for smaller systems and water-cooled, oil-free, three-stage or two-stage boosters for the larger systems. Over the last ten years, four-stage centrifugals have become a popular base-load air compressor, and smaller companies have embraced air-cooled, single-stage lubricated boosters. The king of the hill is still the three-stage, water-cooled, oil-free piston machine.

Here is a recap of the types of blow air compressors that are available today:

- **Three-Stage Lubricated Air-Cooled Piston** — 15/40 CFM; lubricated only; compresses from

atmospheric to 580 psi; maximum flow 40/80 CFM each, so it must be used in multiples; provides backup; good space utilization; moderately efficient; 10- to 12-year service life; very cost-effective for small systems

- **Single-Stage Boosters** — 10/500 CFM; available in lubricated and non-lubricated configurations; uses existing or required inlet air from 125 to 175 psi, depending on pressure; moderate space utilization; reasonably efficient; 10- to 15-year service life; very cost-effective solution to provide PET compressed air

- **Single-Stage Boosters** — 600/2,000 CFM; normally oil-free and water-cooled; uses 125 psi inlet air; low rpm; requires large space; fairly efficient; moderately high-cost; 20- to 30-year service life; used where a large amount of low pressure air is available; realistic costs for large systems

- **High-Pressure Four-Stage Centrifugal** — 1,800/5,000 CFM; oil-free; space-efficient; power cost inefficient unless full load; long periods of low maintenance with costly major rebuild; moderate cost per CFM; 10- to 15-year service life; realistic choice for base-load in large systems

- **Three-Stage Water-Cooled Piston** — 90/1400 CFM; oil-free; water-cooled; reasonably space efficient spending on configuration; most efficient option; can be high on maintenance costs if routine checks are not done at 4,000 to 6,000 hours; highest investment cost per CFM; 20- to 30-year service life; staple of most large production PET plant compressor systems



Single-stage boosters have a long service life and are a cost-effective solution for smaller PET bottling applications.



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11 KEY CONSIDERATIONS FOR SELECTING A PET AIR COMPRESSOR SYSTEM

Defining Blow Air Requirements

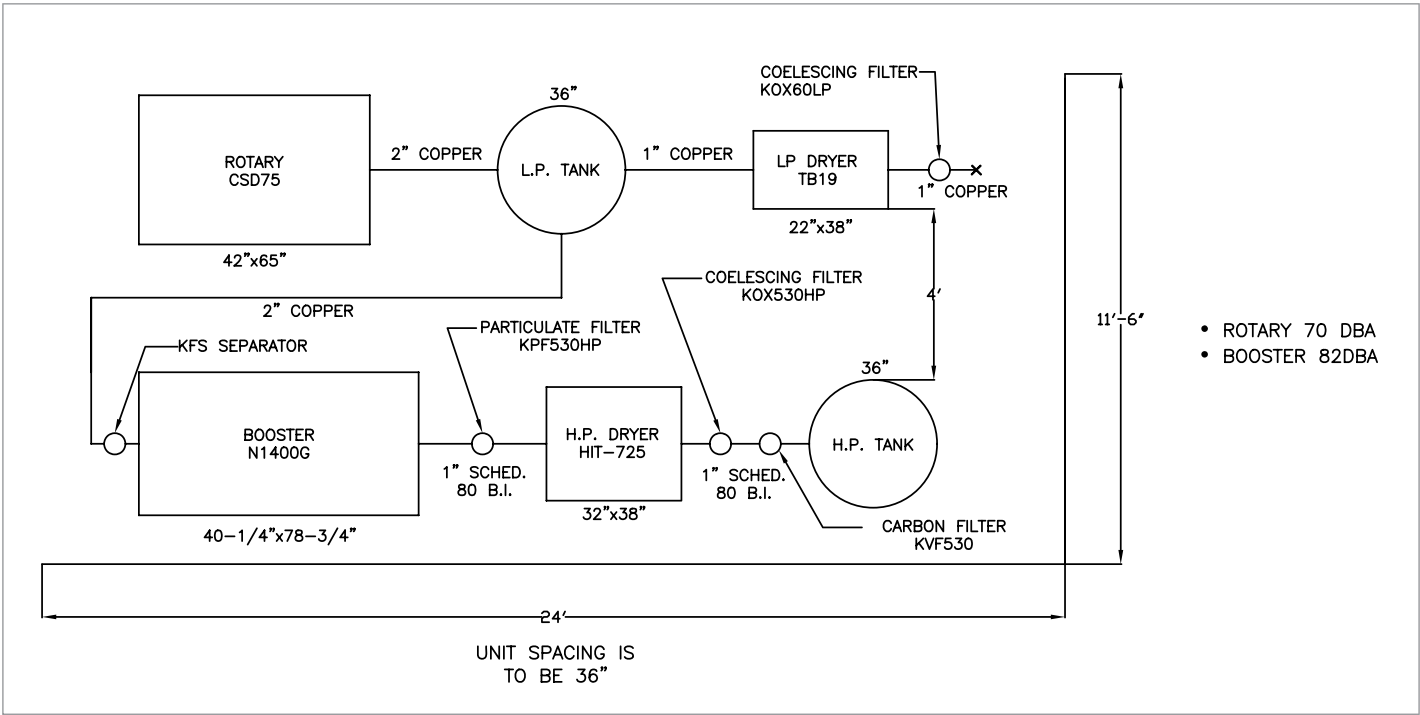
Now that we know what equipment is available, we can evaluate some of the other aspects of determining which compressed air system makes the most sense for various plant applications. Based on the best practices gathered from over 30 years of experience, here are 11 key things to consider when defining the blow air requirements for your application.

- 1. **Plant Type:** Is this a start-up or an addition to an existing facility? How is the access to service and parts? When selecting a compressor for startup and remote applications, you should always try to keep it as simple as possible.
- 2. **Type of Bottle:** Simply designed water bottles tend to have lower pressure requirements when compared to food and pharmaceutical bottles with complex designs. The market will determine the design, and, consequently, the complexity and type of compressor.

- 3. **Air Quality:** Many small and startup bottle-blowing companies use a lubricated, three-stage piston or a lubricated booster with three stages of filtration. The final stage of filtration is a carbon filter for taste and odor removal. Therefore, changing the filter on a regimented basis is critical for successfully using a system of this type (1,000 hours for carbon and 2,000 hours for particulate and coalescing). Air quality sampling is available through many companies, including Trace Analytics to ensure that air quality is maintained and the process adheres to ISO requirements.

Oil-free compressors ensure that no lubricant is used in the cylinder, but they can also pass down particulates and anything in the inlet air. I strongly recommend a particulate filter, and potentially even a carbon filter to ensure proper air quality.

Blow system air dryers are normally the refrigerated type with a 38 °F pressure dewpoint. Some large corporations use desiccant dryers because of previous issues with the failure



Line Schematic of Low Pressure Compressor, Booster, Refrigerated Dryers and Filters

LOW PRESSURE COMPRESSOR					HIGH PRESSURE COMPRESSOR								DRAIN VALVES CHECKED (QTY 5)	NUMBER OF BLOW MOLDERS RUNNING
AIR END TEMP	SEPARATOR DELTA P	DISCHARGE PRESSURE	PRIMARY CYCLE TIME		OIL LEVEL	OIL PRESSURE	DISCHARGE TEMP	BOOSTER CYCLE TIME		BOOSTER PRESSURE		SUCTION PRESSURE		
			LOADED	UNLOADED				LOADED	UNLOADED	LOADED	UNLOADED			

Table 1: Maintenance Checklist for Low-Pressure Air Compressor and High-Pressure Booster Compressor

of refrigerated dryers in their drain systems. Properly maintained refrigerated dryers in most atmospheres will prevent moisture from accumulating in the bottles and molds.

4. **Project Life:** Obviously an investment in a complete PET blow system can be a major expense. If there is a business plan that has a 5- to 7-year window, then a smaller, three-stage PET air compressor or booster is the best candidate. Longer life projects should consider larger, water-cooled PET compressors as a budget permits. Normal investment for a blow compressor system is 20 percent of the new blow machine/mold cost.
5. **Operation Hours:** An obvious consideration is how many hours per year the equipment will be running. Single-shift, five-day operation equates to 2,000 hours, and is common in many small specialty bottle manufactures. This is a logical place for the smaller air-cooled units. As production hours increase to 4,000- to 6,000-hours per year, transition to the larger water-cooled units should be considered, as they tend to have longer service life.
6. **Blow Pressure Required:** As mentioned above, blow pressure started at 250 psi in the early years, and now is hovering around 450 to 500 psi in most applications. Bottle design and machine speed are key factors in the blow pressure requirement. The higher the pressure, the more heat is generated in the compressor, resulting in shorter maintenance intervals and higher power costs. A number of facilities that I have worked with have reduced their pressure by as much as 50 psi, resulting in maintenance reductions and 5 percent power cost savings. This takes some tuning of the blow machine and monitoring of the bottle well as the pressure reduction is taking place.
7. **Equipment Room:** Many times, compressors are installed in whatever space is available, and the positioning of the system is an afterthought. It is critical to consider the following when determining where a compressor can be placed:
 - **Space:** Ensure there is at least a 3-ft clearance around each major component.
 - **Access:** Will you need forklift access for the removal of major components, such as motors, etc.?
 - **Ventilation:** Space should be designed to be no more than outside ambient temperature in the hottest conditions. Air-conditioned environments are a must.
 - **Overhead Gantry:** For larger water-cooled compressors with major components that need to be removed for maintenance, an overhead gantry or an A-frame should be planned as part of the room layout.



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11 KEY CONSIDERATIONS FOR SELECTING A PET AIR COMPRESSOR SYSTEM

- **Future Expansion:** If you think you'll need additional space, piping, compressors or electrical setups in the future, plan your layout accordingly.

- Maintenance Capability:** What in-house capabilities do you have for daily, weekly and monthly maintenance? Unfortunately, PET high-pressure compressors are the most maintenance-intensive component of blow bottle applications. Train your maintenance team to follow maintenance recommendations and record daily. Maintenance at the 2,000-, 4,000- and 6,000-hour intervals are critical to be performed on time. If you do not have the in-house capability, contract with an appropriate service organization. *Timely maintenance is critical to prevent downtime.*
- Backup System:** Facilities that have remote locations or require a 98 percent production rate may realistically require 100 percent backup. It becomes an economic decision of how soon the existing system can be up and running. Many

companies look for a good used or rebuilt system to be used as backup, or place their old system in backup status.

- Power Cost:** Each horsepower used for 4,000 hours at .08 cents a kW costs \$257. If you require 100 CFM at 500 psi, you will use approximately 50 hp, which costs \$12,835 annually and results in a \$50,000 to \$80,00 investment. Ramp up to 500 CFM at 500 psi, and you be spending approximately \$64,172 on 100 hp, requiring a \$20,000 to \$150,000 investment. You can see how power costs affect the bottom line. Here are some key conservation points:

- The compressor should not idle more than 10 minutes.
- Pressure drop should be no more than 15 psi from compressor to blow machine.
- Set pressure for the minimum amount required to blow a good bottle.

H.P AIR "HEADER" SIZING	
40 BAR (580PSI) HP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1"	60
1.25"	130
1.5"	190
2"	380
2.5"	600
3"	1,050
4"	2,200
6"	6,500
8"	13,000

* Based on P.D of 0.2 psi per 100ft pipe

RECOMMENDED MAX. H.P DROP FLOW	
40 BAR (580PSI) HP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1"	100
1.25"	200
1.5"	280
2"	575
2.5"	900
3"	1,600
4"	3,300

* Based on P.D of ~0.5 psi per 100ft pipe

ABS. MAXIMUM H.P DROP FLOW	
40 BAR (580PSI) HP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1"	125
1.25"	275
1.5"	400
2"	800
2.5"	1200
3"	2,250
4"	4,400

* Based on P.D of ~0.5 psi per 100ft pipe

L.P AIR HEADER SIZING	
8 BAR (115PSI) LP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1.00"	30
1.25"	60
1.50"	90
2.00"	165
2.50"	260
3.00"	475
4.00"	900
6.00"	2,900
8.00"	6,000

RECOMMENDED MAX. L.P DROP FLOW	
8 BAR (115PSI) LP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1.00"	45
1.25"	90
1.50"	135
2.00"	260
2.50"	390
3.00"	750
4.00"	1400

* Based on P.D of ~0.5 psi per 100ft pipe

ABS. MAXIMUM L.P DROP FLOW	
8 BAR (115PSI) LP COMPRESSED AIR	
NOMINAL PIPE DIAMETER	MAX FLOW (SCFM)
1.00"	60
1.25"	125
1.50"	185
2.00"	380
2.50"	520
3.00"	1050
4.00"	2000

* Based on P.D of ~1.0 psi per 100ft pipe

Caption: High and Low Pressure Compressed Air Piping Selection

- On multiple machine systems, install a controller to ensure proper load management.
- Install a flow meter to ensure that there is no increase in air usage over time due to mold wear or pipe/equipment leakage.

11. **Piping and Storage:** Correct piping is critical for the proper performance of single or multiple blow machines. Any pressure drop caused by incorrect piping or storage can affect bottle quality. For example, if two or three blow machines happen to cycle at the same time, it can cause a pressure drop to shut all three down — this has happened. Guidelines for piping and drops are provided below, but it is best to review with a trusted engineer.

Over the past 30+ years, I've seen some interesting situations. Some of the worst ones have to do with installations that were downright dangerous as a result of using incorrect pressure fittings or piping. In a few instances, I have seen large compressors with wooden blocks to keep them from shaking because of a maintenance problem.

The most difficult problems to solve are related to pressure and volume. In the beginning, the system may have run well, but, as the compressor and blow machine aged, the pressure may have declined. In such an instance, detective work is required to determine whether it was the blow machine, piping changes or the compressor that started causing problems. The calculation of actual flow requirements for a particular bottle size and production rate is critical to the success of a system. Combine this with a flow meter to determine compressor output, and the solution evolves.

The bottom line is the logical steps for the selection of a PET compressor system depend on the variables outlined above. **BP**

For more information contact Pete Rhoten, Senior Project Engineer, Hope Air Systems, tel: 774-696-6574, email: prhoten@hopeair.com, www.hopeair.com

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Go with the *FLOW*

How Flow Meters Can Help Improve Plant Efficiency

By Scott A. Williams, Contributing Editor

► Plug an electrical device into an outlet. Does it work? Great! For some people that's all that matters. When it comes to compressed air, many manufacturing plants operate the same way. As long as there is enough air, that's all that matters.

But what if cost control also matters to your company? Smart compressed air users may already know how much air they're producing, but they also want to know how much air they're using — and whether they're using it productively. To find out, they're taking accurate, real-time measurements using flow meters.

Flow Meters Provide a Direct Measurement

Instead of attempting to calculate air flow based on assumed relationships between system pressure and a compressor's electrical consumption, or by extrapolating air flow from the time that a

compressor is loaded or unloaded, you can measure the air flow at various points in your facility.

"To begin fixing nonproductive demand, you first need to measure it," according to Jeff Wright, President of Compressor Energy Services (CES), LLC, a compressed air consulting firm based in Merrimack, NH. "CES uses flow meters on every project because they provide a direct measurement of what the compressor is supplying. The Department of Energy states that 50 percent of compressed air goes to nonproductive uses. But, by actually measuring air flow, CES has found the figure is closer to two-thirds of compressed air produced is nonproductive."

Wright explains how flow meters can help you locate where air is being used nonproductively. "Data from air flow meters lets you see the signature of demand events as they happen," he explains. "You can see how compressors respond, how they sequence. Flow meters open up



"To begin fixing nonproductive demand, you first need to measure it."

— Jeff Wright, Compressor Energy Services

a world of understanding in a language the layman speaks. Anyone can look at the LED readout on the flow meter and know what's happening. We get a lot of buy-in from plant workers because they don't have to trust a calculation. They just have to look at the display. There's no black box, no smoke and mirrors trying to relate amps to pressure. Nothing is calculated, only measured."

Flow Metering is Critical to Air Compressor Sizing

Wright, who describes CES as vendor-neutral and energy-biased, points out that flow metering is critical for properly sizing a compressor. "No matter what compressor brand you're looking at, you need to look at your actual flow characteristics and match the manufacturer's curve to get the right fit. Too many people oversize compressors, especially variable speed drive compressors, but buying too big a compressor without addressing nonproductive uses just means you waste air more efficiently than before. If a compressor is too big for demand and has to turn down, it frequently runs on the low end of the performance curve. You can easily find yourself using more power with a larger variable speed drive unit than with a smaller fixed-speed compressor operating in its sweet spot."

Wright recalls a company that conducted an air use audit based on amps and pressure. The results suggested they needed another compressor and they brought in CES to help them size the new unit. "Their impression was they needed more machines to meet demand. We put flow meters on their equipment and demonstrated that they could actually run fewer compressors at full load, where they operate most efficiently, and turn off the ones running at part load."

Using flow data, CES created a blueprint and implemented improvements, which included:

- Fixing leaks
- Programming a solenoid valve so air was only used on equipment that's running
- Installing more efficient nozzles to reduce peak demand
- Modifying piping to resolve pressure problems
- Installing booster pumps where higher pressure was required
- Installing a small, point-of-use compressor on a sand blaster used occasionally
- Improving compressor operating efficiency by utilizing storage



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GO WITH THE FLOW: HOW FLOW METERS CAN HELP IMPROVE PLANT EFFICIENCY

Wright emphasizes that air losses are not always leaks, per se, but waste designed into the equipment by the manufacturer. “Vacuum devices that grab and release work pieces typically have two-position valves,” he explains. “If they remain open when not in the vacuum position, they blow off compressed air continuously. In a noisy environment, you may never hear it.”

When Compressor Energy Services presents to plant managers, they begin by asking how many use flow meters. “Typically it’s about 10 percent,” Wright says. “When we ask how many are actively looking at their metered data, there are only a few left. Facilities already measure consumption of water, gas and electricity, so why not air? It’s the most expensive plant utility — measure it!”

Where to Install Flow Meters

Flow meters range from simple displays of air flow to smart devices that log air flow data, send out alerts if flow exceeds set limits, and send data to networked or remote computers for analysis by engineering staff. By sharing the results of analysis regularly with equipment operators and maintenance technicians, it’s possible to directly relate production output to compressed air consumption. This is valuable for companies that want to assign the cost of compressed air to specific machines, production lines or plant operations with a high degree of accuracy.

“It is worthwhile to learn where expensive compressed air is going, and it’s not all that hard to do,” according to Roger Dennison, President of CDI Meters, Inc., in Woburn, MA. “Measuring compressed air flow throughout your facility allows you to identify leak loads and ineffective uses, which are problem areas you can quantify and correct.”

Thermal mass flow meters employ a simple, direct method of measuring flow, without

imposing a significant pressure loss. They work by sensing the temperature of air in the pipe and the amount of heat required to maintain a heated sensor at a fixed temperature difference above the measured air temperature in the pipe. “The faster air is flowing, the more heat is required,” Dennison explains. “The heat requirement depends on the mass velocity of the air, which means that the meter is measuring the mass of air going by as opposed to the volume. As long as the compressed air has been filtered to remove lubricating oil and dried to remove water droplets, thermal mass dispersion flow meters provide accurate flow data independent of pressure and temperature.”

Dennison designed CDI’s meters as a low-cost method of measuring and saving compressed



CDI 5200 flow meter serving an individual piece of equipment in a ceramics manufacturing plant

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GO WITH THE FLOW: HOW FLOW METERS CAN HELP IMPROVE PLANT EFFICIENCY



CDI 5400 flow meter installed on a major air distribution line in a lamp manufacturing facility

air. Meters clamp directly to a pipe. No welding is required. Two 3/16-inch holes are drilled in the pipe using a drill jig to precisely locate the holes. The flow element and reference element are in separate sensors, one in each hole. The meters operate on 24V DC power. A digital display reads real-time flow in scfm (standard cubic feet per minute), cubic meters per minute or cubic meters per hour. CDI offers an optional Modbus RS485 serial communication output so data can be fed into a local Ethernet network or directly into a host computer. CDI also provides software free for download that will collect and plot the data.

“All CDI flow meters are CE certified and RoHS compliant, have built-in LED displays, and

require no calibration,” Dennison says. “They are available for steel, copper or aluminum piping, and their cost is typically low enough to make them appropriate for installation throughout an air distribution system. Just place them strategically, measure air flows and data log the information.”

Dennison recommends placing a flow meter ahead of each production machine to record the real-time flow for each machine. “Note the flow to each machine when it is idle, either between cycles, at the end of a shift or during a shutdown. Any flow at such times is suspicious, as is any increase in this flow or any difference in flow among similar machines doing similar work. Also consider whether the

flow is reasonable for the benefit provided, and whether the cost is sufficient that alternatives to compressed air should be considered.”

Dennison also points out that maintenance personnel will be more motivated to repair leaks when they can see the reduction in air usage.

Biogen Idec Inc. Uses Flow Meters in Many Areas of Their Facility

Consider how a biopharmaceutical company is using flow meters: “We have an intense energy consumption profile,” says John Kelliher, Senior Plant Engineer with Biogen Idec, Inc., in Cambridge, MA. “That’s why we’re always looking at systems that improve energy consumption and capacity utilization. With compressed air, the approach we used before was simply a timer that recorded how many minutes a compressor was loaded or unloaded. It was pretty crude, actually. Now we use flow meters in many areas of our facility, predominantly labs and research buildings, so we know how much air we are really using. We’re also beta testing flow meters with nitrogen applications.”

Kelliher says that Biogen Idec is constantly upgrading facilities and equipment, so when it comes time to replace a compressor or a dryer, flow meters provide data he can use in selecting a machine this is right sized. “As we upgrade our buildings, we’re often able to downsize our air compressors and dryers,” he explains. “By measuring flow we can determine the right size based on the true connected load



“We use flow meters in many areas of our facility, predominantly labs and research buildings, so we know how much air we are really using.”

— John Kelliher, Senior Plant Engineer, Biogen Idec Inc.

rather than on what the system was designed for when it was installed years ago. Currently about two-thirds of our flow meters are dumb, where we go around and take readings, but as we upgrade our building management system we will integrate the whole compressed air system including smart meters so we'll be able to spot trends in real-time. We're starting to tap resources for better measurement and management of compressed air usage, and flow meters get us in the game without substantial cost."

A Tool to Manage Energy

In his work managing energy with manufacturers, Richard Feustel, CEM, Vice President of the Wisconsin Chapter of the Association of Energy Engineers (WAEE), says he used to attempt flow calculations from the electrical side. He initially used this approach with a manufacturer of marine engines that had a large washing machine with nozzles for blowing off parts.

"This equipment took large gulps of air for periods of two to 30 minutes," Feustel explains, "and it triggered alarms in other places in the network. I thought another compressor was needed. We used pressure gauges and electrical consumption and tried to relate those figures to calculate flow, but trying to determine flow from the electrical side was challenging, expensive and intrusive. It didn't give us a lot of confidence. Measuring air flow was the solution because it gave us hard data to work with."

Measuring, logging and analyzing air flow data led Feustel to a solution involving a large storage tank to support the entire compressed air system. The tank addressed peak demand issues, allowed the existing compressor to operate more efficiently than go on standby, and was less expensive than a new compressor.

Cost of Goods

For increasingly lean, efficient and accountable manufacturing operations, it makes sense to know the cost of compressed air in order to calculate an accurate cost of goods. The compressed air component of that cost is rarely known for particular production lines or production runs, and rarely built into the cost of goods. Typically, the cost of air is estimated or simply rolled up and spread out as overhead across all products.

Using data gathered from flow meters, the cost component of compressed air directly related to a manufacturing process can be determined with a high degree of accuracy. (You might mention this to your accounting staff when you're requesting funding for flow meters!)

Takeaways

For an average investment of \$800 (range of \$500 to \$2,000 per meter, depending on size, application and features) and just a few minutes for installation, flow meters give you real-time data that can help you make meaningful financial decisions. With electricity costs approaching at \$200 per cfm per year in many parts of the country, it's easy to see the advantage. Go with the flow. **BP**

For more information on the organizations discussed in this article, visit Compressor Energy Services (www.compressorenergy.com), CDI Meters, Inc. (www.cdimeters.com), Biogen Idec (www.biogenidec.com), and the Association of Energy Engineers (www.aeecenter.org).

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THE FINAL COST IS DETERMINED BY HOW COMPRESSED AIR IS USED

By Bob Wilson,
Pemco Services



► Corporate announces it is participating in the ISO 50001 Energy Management certification program and issues the edict to all its manufacturing facilities to come up with plan to reduce energy consumption by 25%. Plant management calls a meeting to discuss how this ambitious goal can be met. Since energy is one of the largest controllable components in a compressed air system, the group decides to start there. A recent supply side assessment conducted in conjunction with a compressed air specialist confirmed the compressors are energy hogs. Based upon the analytical simulation run by the specialist, a recommendation was made to upgrade the compressor network with a System Master Control. The project is moving forward making

it good starting point in the overall energy reduction plan. What next?

Lower the Delivered Air Pressure to the System:

Maintenance is responsible for assuring an adequate supply of compressed air is delivered to production. But who has the authority to govern how the air is used? The individual machinery operators always want more air at higher pressures. When the pressure at the use points gets too low, the typical response is to increase the air supply pressure until the complaints go away. The consequence of raising the supply pressure is an added power penalty of 1% at the compressors for each 2 psi increase in pressure. In addition,

leakages increase by about 10% for each 10 psi change in the delivered air pressure. A .25" orifice, for example, will vent 104 scfm back to atmosphere when supplied at 100 psig. At 80 psig, the volume drops to 86 scfm (-20%). The cumulative effect of higher delivered air pressure extrapolated out over the entire facility results in an enormous cost penalty. Management needs to establish standards with regard to how the air is used to include defining acceptable pressure profiles to minimize waste.

While there are numerous resources available to guide an air user on mitigation techniques for lowering the delivered air pressure, most plant managers will benefit from outsourcing



“While there are numerous resources available to guide an air user on mitigation techniques for lowering the delivered air pressure, most plant managers will benefit from outsourcing the services to a compressed air expert.”

— Bob Wilson, Pemco Services

the services to a compressed air expert. The expert will help define the issues and develop a strategy. An air audit will not only lay out a plan to allow lowering the system pressure but also identify how to use air more efficiently. The results achieved with the assistance of an expert will justify the expense.

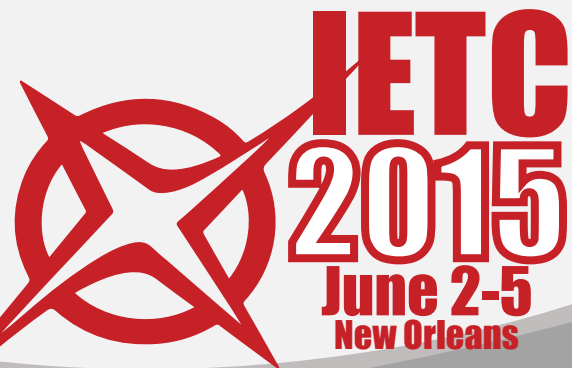
With the application of System Master Control, the air savings in the demand side of the system can translate into a true kW reduction back at the compressor room. A plant air system has both unplanned leakages, which need to be fixed and planned leakages; intentionally created paths to let the air escape back to atmosphere while performing an assigned production tasks. Taking appropriate remedial actions to control how the air escapes

the system offers a huge savings opportunity. In addition to looking at the compressor room, an energy reduction plan must address how air is distributed and how it is used. Some areas of concern:

Regulate the Points of Use:

Left uncontrolled, the air consumed by use points becomes a function of the upstream supply pressure from the compressor room and impediments to flow in the piping distribution system. The resultant distribution imbalance starves some use points of air while others are over pressured and forced to consume more than needed to perform the required task. Every use point has an associated minimum acceptable pressure

required to successfully complete the event. Anything higher will cause waste. The best pressure for completing each task must be identified and an appropriately sized pressure regulator installed to maintain the use point air pressure at the right level. When installing the regulator, inspect the takeoff line and hoses to ensure no excess pressure drop has been introduced by the addition of improperly sized filter/lubricators, shut off valves, or other poor hose connection practices. It is important to secure the regulator in a manner that discourages tampering by operators. Lockable regulators are available for this purpose. Regulators can also be installed in lockable panels or in an inaccessible location like higher up in the ceiling.



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THE FINAL COST IS DETERMINED BY HOW COMPRESSED AIR IS USED

Apply Storage Solutions:

Compressors cannot push air through a system. It's not like pumping water. To get air to flow, low pressure points must be created. Air will then flow from the higher pressure areas to the lower pressure areas. It is important to recognize the function of the pipes when taking actions to improve how the air travels through the system. The pipes are the conduit

to flow the air from the compressor room to the connected production demands. They are also the fixed volume vessel that stores the air in advance of production demands. Both these functions must be considered when developing plans to improve the performance of a system.

The stored air volume is expressed by the equation:

$$V_s = V_f \times \Delta P / P_a$$

Where V_s = stored volume (cubic feet) ΔP = change in pressure (psi)

P_a = atmospheric pressure (psia)

V_f = fixed volume of vessel (cubic feet)

Note the two variables that determine the stored potential energy in a system are the fixed volume vessel and the allowable change in pressure within the storage vessel. In a plant air system, the piping distribution system is the fixed volume vessel. The degree that the pressure is allowed to decay determines the amount of stored energy available from the piping distribution system to support production. Since the piping volume is fixed, the only immediate remedy available to increase the stored energy is to raise the pressure for the entire system. This results in increased air consumption and wasted energy.

The volume of the system can also be increased by the placement of air receivers at strategic locations. Pressure reducing stations can then be configured to control the release of the stored air to satisfy a definite purpose task. Some examples of storage solutions:

- **Secondary storage receivers** can be installed to mitigate transmission times as the air travels throughout the piping distribution system. Storing air where it will be used relieves the piping conduit of storing high pressure air in advance of the event. The pipes main function becomes replenishing the air in the receiver during the dwell times of the demand cycle instead of acting as a storage vessel. In this manner, the speed, thrust, or torque of an application can be

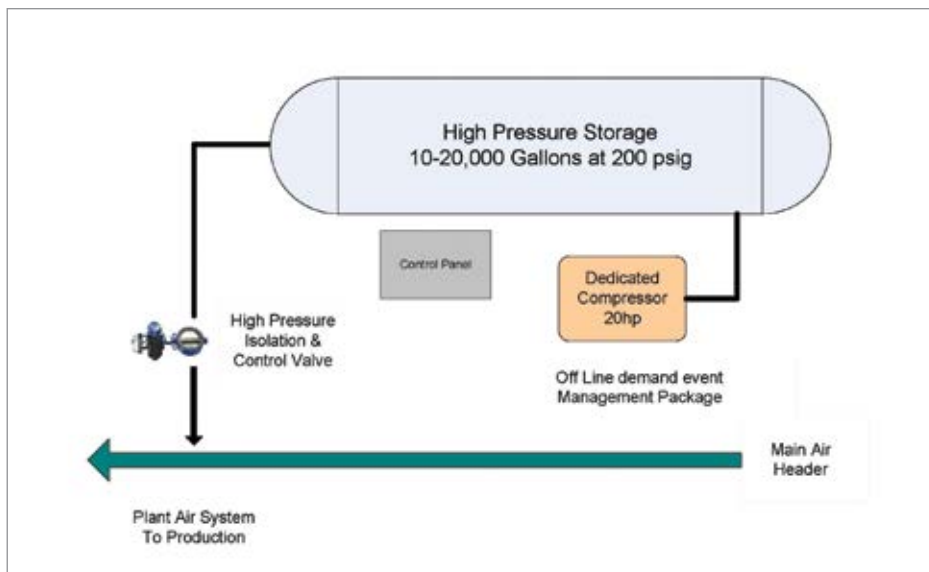


Figure 1. Off line demand event management system.

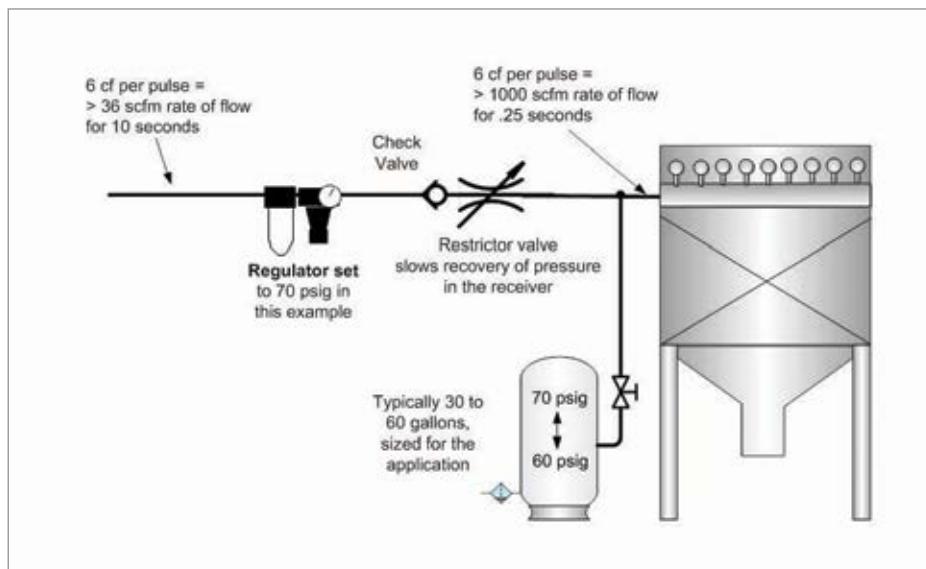


Figure 2. Metered storage on a dust collection process

Illustration courtesy of Compressed Air Challenge, "Best Practices for Compressed Air Systems." Manual

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THE FINAL COST IS DETERMINED BY HOW COMPRESSED AIR IS USED

refined. Intermittent surge loads such as dense phase conveying can be dealt with from locally stored air. Storage can also be used to positively pressurize cargo vessels in tanker trucks and railcars before the material offloading process can begin. Satisfying intermittent demands from locally installed air storage receivers will save air usage and its associated costs.

- **Dedicated storage** can protect critical processes against unacceptable pressure fluctuations. The receiver dedicated to the process is sized to ensure the pressure change stays within an acceptable range under all dynamic load conditions.
- **Off line high pressure storage** can be engineered to function as a demand event management

system. A large receiver is pressurized by a small dedicated compressor to a much higher level than the main plant air system provides standby storage sufficient to sustain the system pressure during large intermittent demand events. The package is side streamed so it is not in the main air flow path. It can also be sized to maintain the air supply for a predetermined period of time to allow machinery to safely shut down in the event of an unanticipated failure of the air supply.

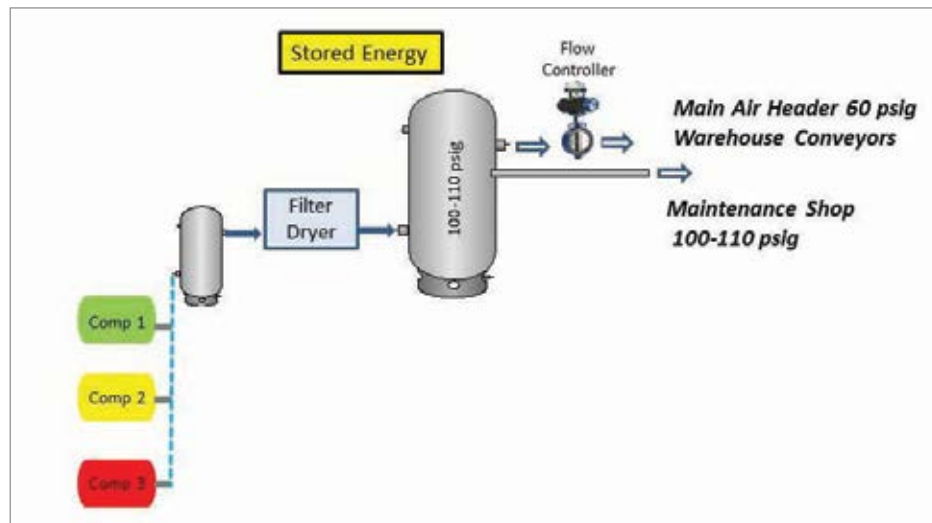


Figure 3. Sected storage example

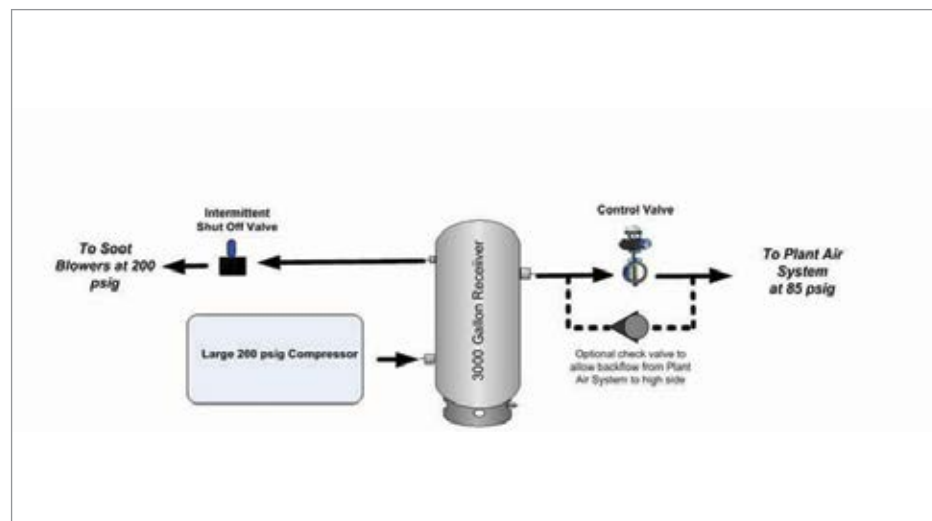


Figure 4. Spill valve arrangement with optional backflow check valve

- **Metered storage** can be applied to isolate the main air system from the impact of short duration high volume loads like the pulse jets that knock off the cake in dust collection and bag house processes. A properly sized receiver tank and/or multiple accumulators are installed in the air line supplying the workstation. The pressure supplied to the storage vessel(s) is regulated down to a level that will efficiently dislodge the cake off the bag without excessive impingement forces. In addition to using less air, collector bag life is extended. A check valve upstream of the regulator ensures the definite purpose air stored for the process will not flow back into the main air system if a low upstream pressure conditions occurs. Some processes may benefit from putting a manually adjustable needle valve on the

supply pipe to meter the rate of air replenishment to prevent draw down of the main air system when the storage recovers.

Sector the Air Distribution System:

- An opportunity exists in many plant air systems to deliver the air at different pressures by sectoring the piping distribution systems. Instead of maintaining the entire air system at the highest required pressure, multiple sectors can be configured for delivering the high pressure air to only those areas of the plant that require it. The remainder of the plant can then operate at a lower pressure to save air and operating costs. Some examples:
- Figure 3. shows an independent dedicated supply line connected from the main air storage receiver to a maintenance shop area that requires higher pressure air.
- Plants with multiple production areas all operating in common with the main air supply header can be sectorized using remotely activated isolation valves. During prolonged non-production periods, air to the respective sector can be shut off or pressure reset to a much lower level just to keep the pipes full.
- Plants which have two separate compressed air systems can arrange to spill air over from the higher pressure system to an adjacent lower pressure

production area. This will keep the high pressure compressor fully loaded for longer times, operating at peak performance instead of idling inefficiently or blowing off to atmosphere. For systems where the high pressure area is only marginally higher than the main air system, a check valve can be added to allow air to automatically backflow in the event of emergency.

Optimize How the Air Is Used:

A big savings opportunity exists by eliminating air waste and inappropriate uses. Look at alternative methods for accomplishing tasks more efficiently. Keep in mind it takes 7-8 electric horsepower to deliver 1 pneumatic horsepower. Some examples

- For low pressure applications, fans and single/two-stage blowers can be applied.
- Replace inherently inefficient air motors with electric motors where possible.
- See if it makes sense to use vacuum pumps instead of air operated venturi nozzles.
- Consider using an electric motor driven mechanical pump rather than an air operated diaphragm pump.
- Install no air loss condensate drains.
- Use high efficiency nozzles, air knives, and air amplifiers on open blowing processes.

- Look at ways to cool cabinets other than with open tubes, air bars, or vortex tube coolers.
- Eliminate compressed air people coolers.

Summary:

The costs associated with running a compressed air system are much like the costs to operate a car. Money spent to purchase fuel is the investment. Until the car is driven, however, the fuel is still in the tank and hypothetically could be exchanged back for money. The final cost of the fuel will depend on how the car is driven. Steady highway driving will cost a lot less per mile than aggressive driving, driving in stop and go city traffic, and heavy hauling. Poor maintenance will also increase the cost per mile. The compressed air system is the same way. The power purchased to compress the air and hold it in storage is the investment. The cost is incurred when the air is used and the final cost of the air will be determined by how it is allowed to escape the system. Think unintentional and intentional leaks! Lowering air pressures, controlling use points, applying storage appropriately, and eliminating wasteful practices will save on the air consumed at use points. Less air usage translates to a reduction in the energy investment back in compressor room. The facility is on its way to achieving ISO 50001 Energy Management certification. **BP**

For more information contact Bob Wilson, PEMCO Services, email: rwilson@pemcoservices.com, www.pemcoservices.com

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ACRYLON PLASTICS OPTIMIZES COMPRESSED AIR SUPPLY TO ROTARY MOLDING PROCESS

By Ron Marshall for the
Compressed Air Challenge®



► Acrylon Plastics located in Winkler, Manitoba, Canada manufactures an extensive variety of custom plastic parts for a wide range of end use applications including Residential and Commercial Windows & Doors, Buses, Tractors, Combines, Electric Cars, Fencing, Commercial Building Systems and Residential Playground. The production in the Winkler plant using a rotational molding process. Years ago changes to their production volumes increased the compressed air flows to above what their compressed air system could deliver. As a result the plant pressure would fall to low levels during production peak demands, which negatively affected sensitive compressed air powered machines. In addition to this during light plant loading conditions the air compressors would run inefficiently. Plant personnel tried a variety of strategies to

deal with the plant peaks, with the most efficient solution coming as a result of installing VSD style compressors and pressure/flow control.

Initial State

When producing large plastic parts with rotary molding process plastic medium is blown into a large mold and the mold is heated and rotated along two axes. In doing this the plastic forms a skin on the inside of the mold and the part that is formed is hollow. The rotating motion prevents the piece from drooping internally while it is forming and cooling. Some of Acrylon's products are still quite soft when they are cooling and being removed from the mold so an amount of compressed air must be blown into the piece to slightly



“Years ago changes to their production volumes increased the compressed air flows to above what their compressed air system could deliver. As a result the plant pressure would fall to low levels during production peak demands.”

— Ron Marshall, for the Compressed Air Challenge®

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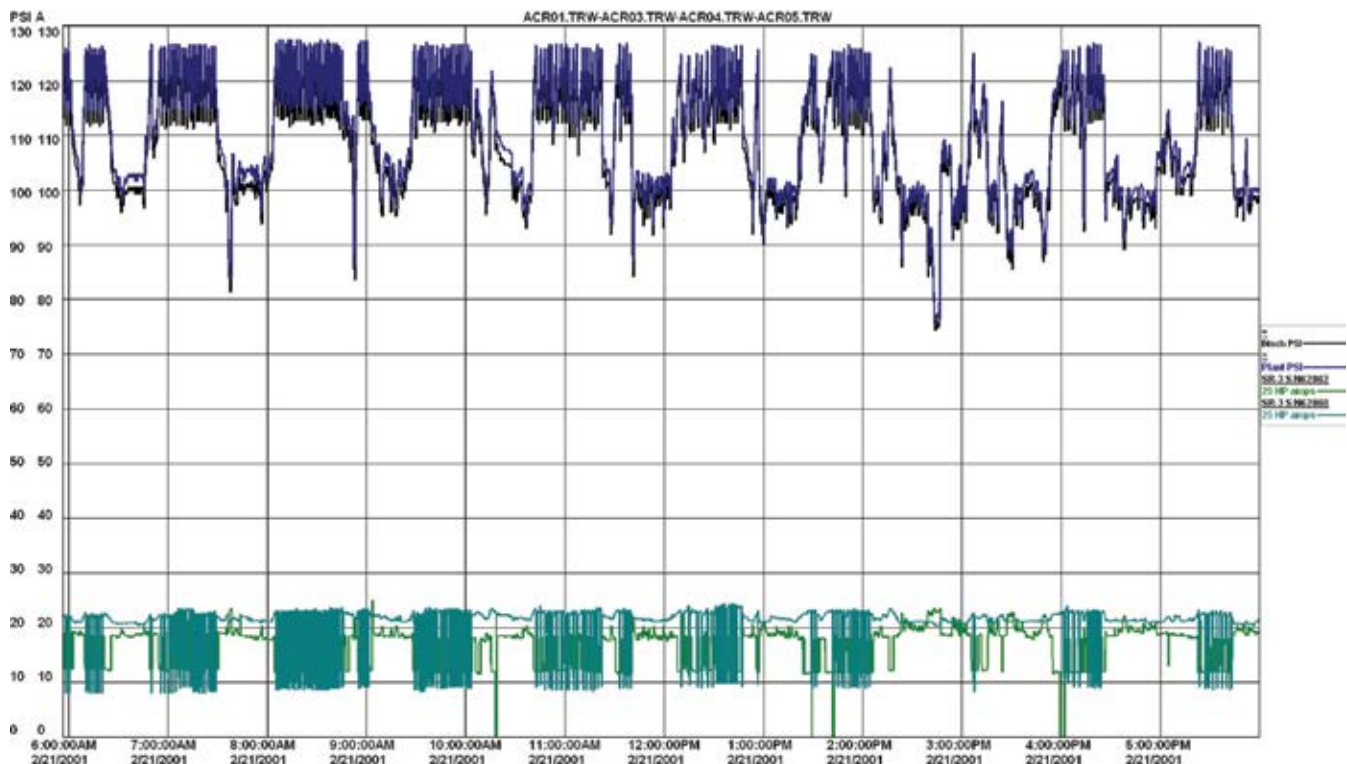


Chart 1: As found data logging with poor pressure control and inefficient compressor operation

COMPRESSED AIR EFFICIENCY OPTIONS AT A ROTARY MOLDER

pressurize it and to cool the inner surfaces. This significant flow of compressed air was pulling down the plant pressure causing poor pressure regulation. Data logging in Chart 1 shows the pressures ranged from a high of 125 psi, the maximum rating of the main compressor, to as low as 75 psi during random production peaks.

Installed at the site were two 25 HP compressors with very little storage receiver capacity. One unit was capable of pushing the plant pressures higher to try to ride out the events, but the other was only rated at 100 psi and had to run in modulation mode with full flow only being produced when the pressure fell to under its rating.

Adding Storage

Acrylon was considering the purchase of a new larger compressor that was capable of higher pressure operation which would store more air in local storage receivers. About this time variable speed drive compressors were being offered by suppliers and Acrylon approached their local power utility to help with the costs because the VSD compressors are more expensive than fixed speed units. The power utility did calculations that showed that the more efficient operation of VSD's at low loads would pay for the incremental purchase price through significant savings and the power bill.

Acrylon found that a 60 hp compressor was affordable, but due to the high flows involved

in processing their parts, some stored air was needed to prevent plant pressure issues. If large air storage wasn't installed an additional fixed speed compressor would have had to start to support the pressure. This would increase the energy consumption because the unit would run unloaded for significant periods of time.

A 1,060 gallon storage receiver was purchased with a pressure flow controller. The plant implemented a storage strategy where the air compressor would produce compressed air at 135 psi and the plant pressure regulated down to about 90 psi. Whenever the plant flows exceeded the capacity of the main compressor some air was drawn from storage, as seen in Chart 2,

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rather than starting another compressor. If the pressure/flow controller was not used, in this case, the plant would have seen excessive pressure, causing all pressure sensitive compressed air consumers to use more compressed air (called artificial demand). It can be seen in Chart 2 there are still some occasions where plant pressure falls to lower levels when all the air stored in the receiver has been used up. The solution to this would be to add more storage capacity. These pressure reductions occurred during non critical times due to clean-up activities.

A disadvantage of this high pressure system of storage is that the discharge pressure of the air compressor is much higher than the required plant pressure. Due to the higher pressure the

compressor will consume more energy per unit of flow output. But in this case the energy consumed and the electrical peak demand charges incurred were lower than would have been consumed by a second running fixed speed compressor. The system saved about 46% in energy costs over the base case scenario or adding a third compressor.

Adding A New Compressor

This system worked adequately for many years and eventually Acrylon decided to purchase a second compressor to replace the old fixed speed backup unit. This was an opportunity to enhance the savings of the project due to the characteristics of VSD's. The previous fixed speed compressor ran in the load/unload

mode with auto shutoff. When it started it had to run for a fixed period of time to prevent the maximum allowable number of motor starts from damaging the motor. But VSD's can start and stop much more often and most are not required to run unloaded for a cool down period.

It was decided to change the system and install a new larger 75 hp VSD compressor. The original VSD was set to provide backup to cover the occasional peak flows. In this case the main VSD does not now have to run at high pressure to store compressed air for later use, the larger capacity plus the backup was enough to fully cover peak flows. This meant that discharge pressures could be reduced so the new system could run with lower energy

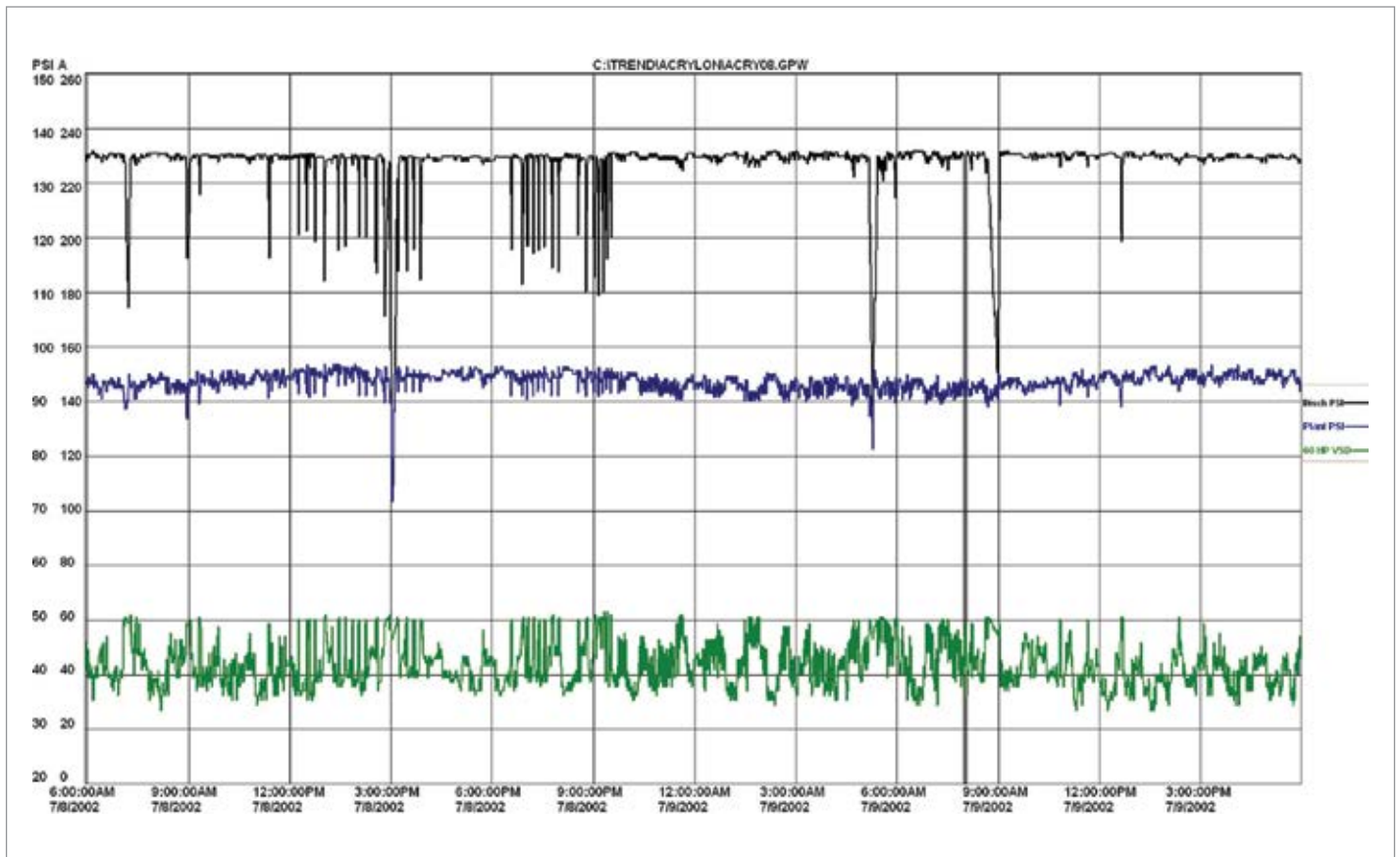


Chart 2: Running high discharge pressure into large storage prevents the start of a second compressor

COMPRESSED AIR EFFICIENCY OPTIONS AT A ROTARY MOLDER

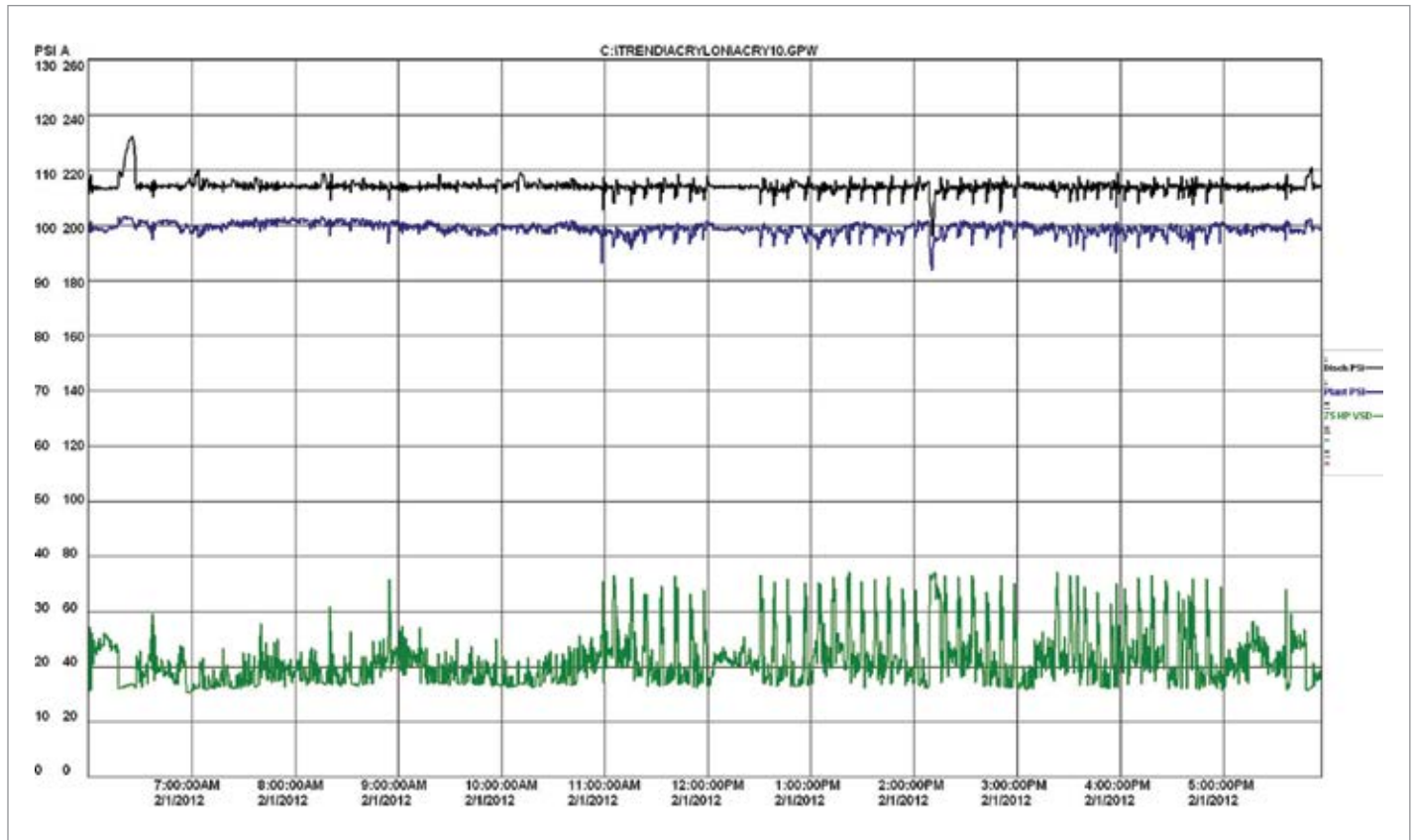


Chart 3: Use of VSD sized for the load set at lower pressure saved energy

consumption. The second VSD will start only for the periods of time required to save the system pressure from falling below required levels. Once it is not needed it immediately shuts off with no unloaded run time.

System operation is shown in Chart 3 where the main compressor discharge pressure is now 108 psi. For the data in Chart 3 the second compressor was turned off temporarily but is normally set to start when the storage

pressure drops below 100 psi. The system electrical costs for this system were reduced a further 34% due to the lower pressure and the increased efficiency of the newer compressor.

Conclusions

This case study shows that a number of strategies can be used to deal with peak flows. Large storage can prevent the start of a second compressor which would boost energy and demand costs. But the excellent characteristics of VSD compressors can be used to further save energy costs if configured correctly to supply peak flows at lower pressures. **BP**

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"Sullair has a strong reputation for the durability of its air compressors," states Tim Kruto, Senior Product Manager, Aftermarket Products, Sullair. "And Sullube has played a major role in helping keep our air compressors running optimally. This new formulation combines the benefits Sullube has historically provided, and adds additional value with the extended fluid life all backed by the expertise of Dow."

According to Flavio Kliger, Market Portfolio Director for Performance Lubricants, Dow Chemical Company, "Dow and Sullair share an uncompromising commitment to quality that creates the perfect foundation for our partnership in producing Sullube. We look forward

to continuing our work together enabling Sullair to provide the rotary screw air compressor market with high performance lubricants, as we have for over three decades."

The Sullair/Dow relationship is more than just a supplier/customer relationship. The Dow Chemical Company has relied on Sullube to help keep its own compressors running optimally.

"We have counted on Sullair for its best-in-class efficiency and reliability for more than 30 years and look forward to continuing that strong relationship with them for years to come," says Keith Kenebrew, Associate Commercial Director for Dow Hydrocarbons & Resources LLC.

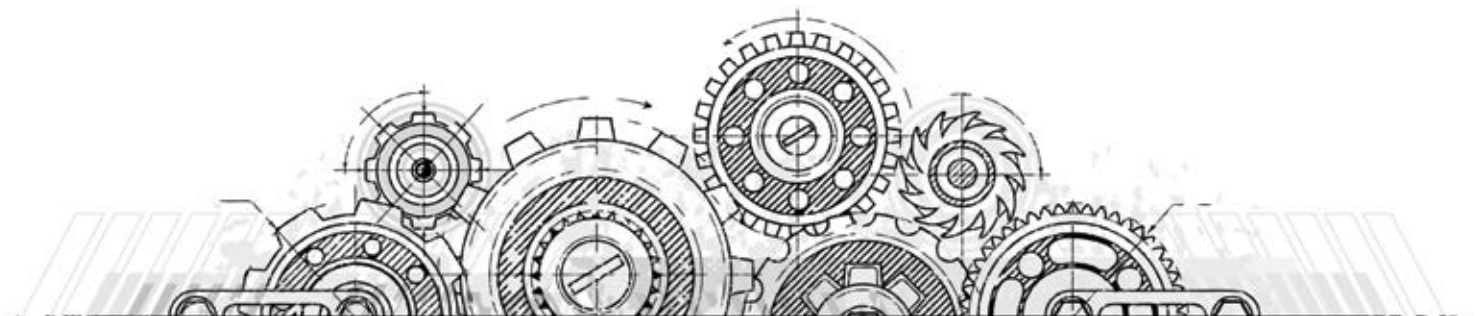
To launch the improved formulation of Sullube, Sullair and Dow have been conducting training sessions and webinars with Sullair distributors throughout the world. Additionally, a website has been launched — Sullube.com — to provide additional information and resources about Sullube and other Sullair compressor lubricants.

To learn more about Sullair and its products, visit www.Sullair.com.

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THE MARKETPLACE

JOBS

**Cleveland
Brothers****SULLAIR SALES REPRESENTATIVE**

Based in Wilkes Barre PA, this position is responsible for marketing and selling air compressors, dryers, filters, and preventative maintenance contracts to the industrial, large commercial, quarry & aggregate plants, power plants, and waste water industries in the assigned territory of Wilkes-Barre, Scranton, Lehigh Valley regions.

Job Duties: Successfully sell new industrial air compressors, rent temporary backup compressors, and sell product support services for air compressor equipment; influence all other products and services offered by the enterprise and pass on leads where appropriate; build and maintain relationships with all appropriate decision makers and influencers within the assigned territory.

Preferred candidate will have: a Bachelor Degree in Marketing, Business Administration, Engineering or a related field, combined with two to five years of progressive sales experience.

Please apply at: <http://www.clevelandbrothers.com/careers>. Requisition 337

SALES MANAGER

The Titus Company, a growing family business specializing in compressed air systems and products, headquartered in Morgantown, PA, is seeking a Sales Manager to increase sales and provide leadership to the department ensuring profitable growth for the company. Successful candidate will have a proven track record in effectively increasing sales, developing people/teams and leading marketing & business development efforts.

This professional individual will work to meet strategic objectives, bring an innovative hands-on approach to sales, and have a strong understanding of finances and budgets. A minimum of 5 years sales management experience required. Chemical/Industrial/Electrical/Manufacturing industry knowledge, specifically nitrogen & industrial gases, a plus. An engineering degree, bachelor's degree or equivalent experience in related area desired. Computer proficiency and ability to understand technical information essential.

Please provide a letter of qualification and resume to our consultants:
www.northgroupconsultants.com/jobs

**DANMAR INDUSTRIES, INC.
HOUSTON, TEXAS**

A Gardner-Denver distributor has an immediate opening for a sales person with 3+ years' experience in outside sales of compressed air systems.

Position Includes:

- Base salary plus commission
- 401K Plan
- Insurance Options
- Paid Vacation

Submit Resume to:

Melinda Niewiemiński
melinda@danmarind.com
(281) 230-1000

**FIELD SERVICE TECHNICIAN**

Blackhawk Equipment Corporation, founded in 1985, is the premier rotary screw, oil free, and centrifugal air compressor distributor in Colorado. Also specializing in air dryers, cooling towers, air audits, air tools, custom controls, engineered skid packages, portables and rental air.

We consider service to be the backbone of the organization, and are looking for a motivated self-starter with the ambition to grow and increase the service excellence we continually strive for.

Responsibilities:

- Troubleshoot, repair, maintain and install all types of air compressors, air dryers and filters.
- Firsthand experience with rotary screw compressors and centrifugal compressors.
- Read prints, wiring schematics, and diagrams for all equipment.
- Interface with customers with a sense of pride and professionalism.
- Overtime and travel may be required.



Get to know
Blackhawk Equipment...
<http://youtu.be/3pZW15rqfCc>
www.blackhawkequipment.com

Required Qualifications:

- Two to five years of previous mechanical/service experience.
- Troubleshooting skills are a necessity.
- Knowledge of electrical, pneumatic and mechanical systems.
- Excellent customer service skills.
- Self-directed, perform duties without direct supervision.
- Basic maintenance tools are required.
- Clean motor vehicle record.

Compensation: Commensurate with Experience

Benefits including: health and dental insurance, paid holidays and vacation, short-term and long-term disability and 401K.

Relocation assistance will be considered based on experience!!

Please submit resumes to
info@blackhawkequipment.com.

JOBS

**SERVICE MANAGER – 2 LOCATIONS!**

IAC is an industrial distributor of compressed air and vacuum products, parts, service, installation, and energy management solutions for customers in Kentucky, Ohio, and Indiana. Founded in 1991, IAC has distinguished itself by approaching compressed air as one of industry's most critical resources. Our engineering group provides a wide variety of options and products to assist customers in reducing energy costs. IAC has also expanded to offer products and services to the industrial and commercial power generation market.

We currently have Service Manager positions open in two of our locations: Indianapolis, IN., and Jeffersonville, IN (Louisville area).

Job summary:

The position responsibilities will include managing all activities of the service department, including, the management of all processes and procedures

to ensure the highest efficiency and productivity of the department. Also, leading, motivating and directing the service department personnel to create an environment where customer service, teamwork and overall excellence become our passion. The candidate should possess the skills and experience to manage the aggressive growth expectations and business development of the service department.

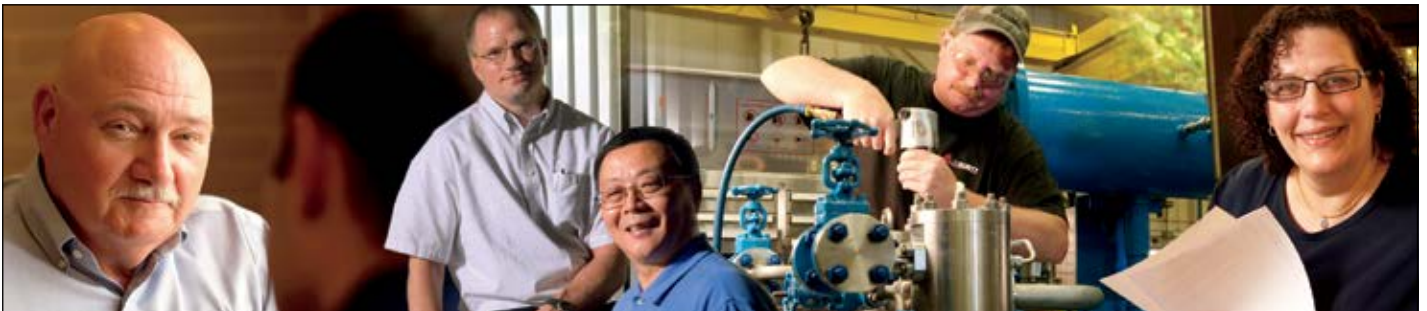
Minimum requirements:

3-5 years' experience in customer service industry along with a mechanical knowledge of industrial equipment. A Bachelor's degree and a background in sales are a plus.

Compensation: Commensurate with Experience

Benefits including: health and dental insurance, paid holidays and vacation, life insurance, short-term and long-term disability and 401K.

Please submit resumes to dsuder@iacserv.com

**Sales Engineer - U.S. North Central Region**

FS-Elliott Co., LLC is a leading manufacturer of oil-free centrifugal air and gas compressors with sales, service, and manufacturing locations around the world. First introduced to the market over 50 years ago, our energy-efficient compressors incorporate the latest aerodynamic and control system technologies to ensure optimum performance.

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THE MARKETPLACE

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